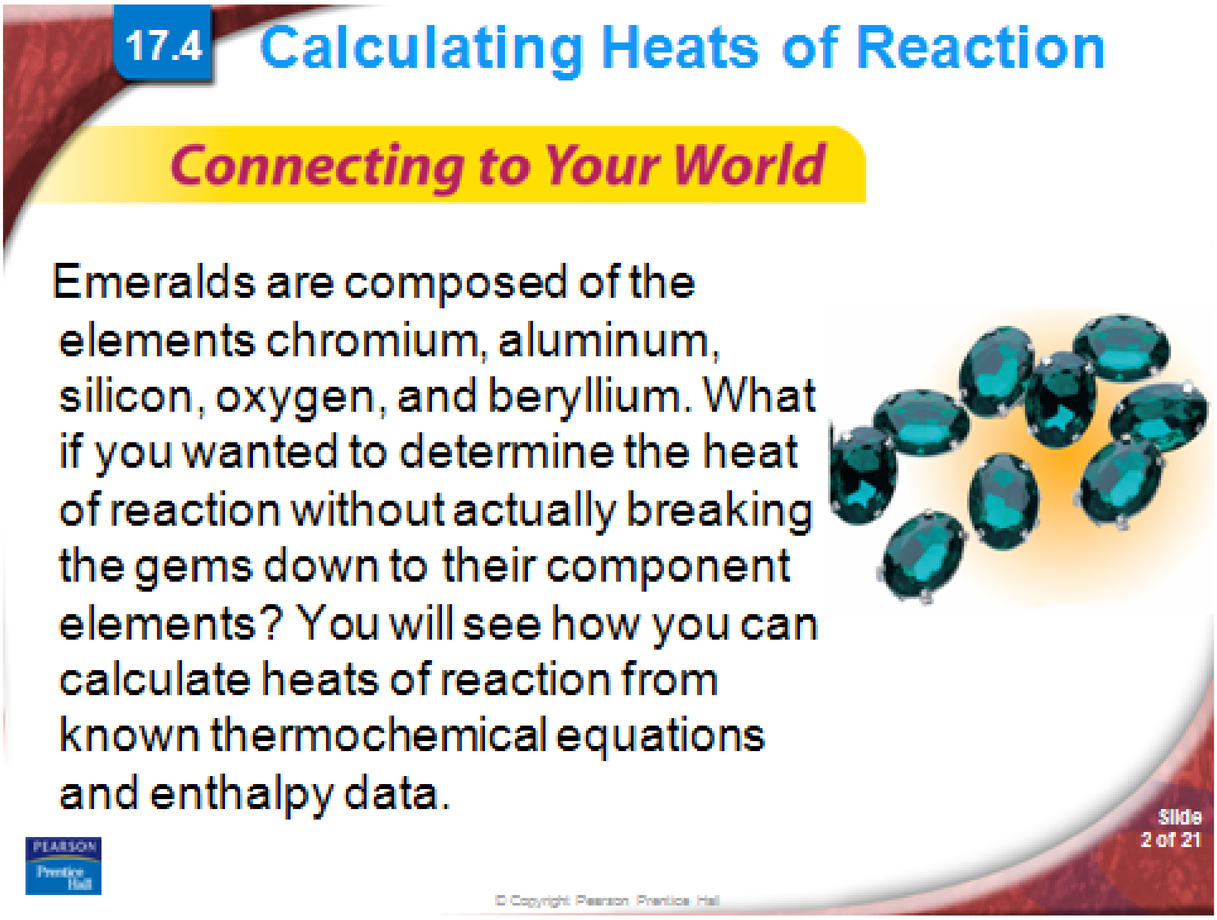
Predicting Enthalpy Changes


17.4
Calculating Heats of Reaction
Connecting to Your World
Emeralds are composed of the elements chromium, aluminum, silicon, oxygen, and beryllium. What if you wanted to determine the heat of reaction without actually breaking the gems down to their component elements? You will see how you can calculate heats of reaction from known thermochemical equations and enthalpy data.
Slide
2 of 21
© Copyright Pearson Prentice Hall

17.4 Calculating Heats of Reaction > Hess's Law

Hess's law allows you to determine the heat of reaction indirectly.

Hess's law of heat summation states that if you add two or more thermochemical equations to give a final equation, then you can also add the heats of reaction to give the final heat of reaction. (ΔH_r)

Slide 4 of 21

Hess's Law-The addition of chemical equations yields a net equation who enthalpy change is the sum of the individual positive or negative enthalpy changes

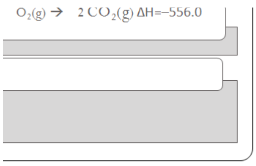
$\Delta H_{net} = \Delta H_1 + \Delta H_2 + \Delta H_3 + \ldots$

$\Delta H = \sum \Delta H_r$

Summation

Two general rules:

1. → if you reverse an equation then the sign of ΔH_r also reverses
2. → If you multiply or divide an equation by a value then ΔH_r is also altered in the same way.



Finding ΔH using Hess's Law (using reactions with energy)

Find ΔH_f for the following:

NET $C(s) + 1/2\ O_2(g) \rightarrow CO(g)$ $\Delta H = ?$

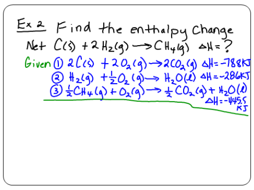
same ① $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5\ kJ$

② $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$ $\Delta H = -556.0\ kJ$

① $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5\ kJ$

② $CO_2(g) \rightarrow CO(g) + \frac{1}{2}O_2(g)$ $\Delta H = +278.0\ kJ$

$C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g)$ $\Delta H = -115.5\ kJ$



Ex. 2

Find the enthalpy change

Net $C(s) + 2\ H_2(g) \rightarrow CH_4(g) \quad \Delta H=?$

Given Info.

① ÷2 $2C(s) + 2O_2(g) \rightarrow 2CO_2(g) \quad \Delta H=-78.8\ kJ$

② x2 $H_2(g) + \frac{1}{2}\ O_2(g) \rightarrow H_2O(l) \quad \Delta H=-286\ kJ$

③ x2 rev $\frac{1}{2}\ CH_4(g) + O_2(g) \rightarrow \frac{1}{2}\ CO_2(g) + H_2O(l) \quad \Delta H=-445.5kJ$ (↑ +)

① $C(s) + O_2(g) \rightarrow CO_2(g) \quad \Delta H=-39.4KJ$

② $2H_2(g) + O_2(g) \rightarrow 2H_2O(l) \quad \Delta H=-572KJ$

③ $2H_2O(l) + CO_2(g) \rightarrow CH_4(g) + 2O_2(g) \quad \Delta H=891KJ$

$C(s) + 2H_2(g) \rightarrow CH_4(g) \quad \Delta H=279.6KJ$